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(71) Applicant: Sumitomo Naugatuck Co., Ltd.  
No. 3-2-4, Nakanoshima Kita-ku  
Osaka-shi Osaka-fu(JP)

(72) Inventor: Saeki, Tadashi  
6-8-24, Shonai-cho  
Niihama-shi Ehime-ken(JP)  
Inventor: Ikawa, Kiyoshi  
3-4-48, Shinsuka-cho  
Niihama-shi Ehime-ken(JP)  
Inventor: Kurita, Seiji  
2-5-13, Nishibara-cho  
Niihama-shi Ehime-ken(JP)  
Inventor: Ueno, Katsuji  
1-5-20, Wakamizu-cho  
Niihama-shi Ehime-ken(JP)

(74) Representative: von Kreisler, Alek et al  
Patentanwälte Von Kreisler-Selting-Werner  
Deichmannhaus am Hauptbahnhof  
D-5000 Köln 1(DE)

(54) Thermoplastic resin composition.

(57) A thermoplastic resin composition comprising:

- (A) polyamide having a relative viscosity in sulfuric acid of not smaller than 2.0 and smaller than 3.0,
- (B) a graft copolymer which is obtainable by copolymerizing an aromatic vinyl monomer, a cyanated vinyl monomer and other vinyl monomer copolymerizable with the former two monomers in the presence of a rubbery polymer and
- (C) a carboxylic acid-modified copolymer comprising monomeric units derived from an aromatic vinyl monomer, a cyanated vinyl monomer and an  $\alpha,\beta$ -unsaturated monocarboxylic acid wherein a weight ratio of polyamide (A) to a total amount of the graft copolymer (B) and the carboxylic acid-modified copolymer (C) is from 90:10 to 10:90, the content of  $\alpha,\beta$ -unsaturated monocarboxylic acid is 0.1 to 1.5 % by weight based on the total amount of the graft copolymer (B) and the carboxylic acid-modified copolymer (C), and the content of rubbery polymer is 5 to 30 % by weight based on the whole weight of the composition.

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## THERMOPLASTIC RESIN COMPOSITION

### BACKGROUND OF THE INVENTION

#### Field of the Invention

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The present invention relates to a thermoplastic resin composition. More particularly, it relates to a composite type thermoplastic resin composition which comprises polyamide, a specific graft polymer and a specific copolymer modified with an unsaturated carboxylic acid and has well balanced impact strength (namely notched izod impact strength), moldability and tensile strength, and weld strength as well as appearance.

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#### Description of the Prior Art

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Polyamide resins are excellent in moldability, heat resistance, mechanical strength, chemical resistance and wear resistance and widely used as materials of, for example, machine parts, electric and electrical parts and automobile parts. However, they suffer from decrease of impact strength in a dry state, and dimensional change and/or decrease of tensile strength due to moisture absorption.

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As typical impact resistant rubber-modified resins, acrylonitrile-butadiene-styrene (ABS) resins, AES resins comprising ABS resins a rubber component of which is replaced with ethylene-propylene base rubber and AAS resins comprising ABS resins a rubber component of which is replaced with acrylic rubber are known and widely used as materials of automobile parts, electrical equipment parts, business machine parts. Although these resins are excellent in impact strength and dimensional stability, they usually have relatively poor chemical resistance, and a high impact grade which contains the rubber component in an increased content has decreased tensile strength and moldability.

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To overcome the above drawbacks, it was proposed to melt mix polyamide with the ABS resin (cf. Japanese Patent Publication No. 23476/1963). However, since the compatibility between polyamide and the ABS resin is inherently bad, a molded article suffers from delamination and provides an article having low impact strength.

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It has been proposed to introduce a functional group having reactivity or affinity with polyamide such as carboxylic acid group and an amide group in the ABS resin so as to modify the ABS resin and to increase the compatibility between polyamide and the ABS resin (cf. Japanese Patent Kokai Publication Nos. 11159/1979, 32656/1983 and 93745/1983). However, the introduction of such functional group to the ABS resin may result in great decrease of moldability and unsatisfactory improvement of impact strength. Further, an article molded from the mixed resin has less weld strength (strength along a weld-line).

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### SUMMARY OF THE INVENTION

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An object of the present invention is to provide a thermoplastic resin composition comprising a polyamide resin and an ABS resin, which has good moldability and provides a molded article having balanced impact strength and tensile strength and good weld strength.

According to the present invention, there is provided a thermoplastic resin composition comprising:

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(A) polyamide having a relative viscosity in sulfuric acid of not smaller than 2.0 and smaller than 3.0,  
 (B) a graft copolymer which is obtainable by copolymerizing 50 to 90 % by weight of an aromatic vinyl monomer, 10 to 50 % by weight of a cyanated vinyl monomer and 0 to 40 % by weight of other vinyl monomer copolymerizable with the former two monomers in the presence of a rubbery polymer and

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(C) a carboxylic acid-modified copolymer comprising monomeric units derived from 50 to 89.5 % by weight of an aromatic vinyl monomer, 10 to 49.5 % by weight of a cyanated vinyl monomer and 0.5 to 20 % by weight of an  $\alpha,\beta$ -unsaturated monocarboxylic acid

wherein a weight ratio of polyamide (A) to a total amount of the graft copolymer (B) and the carboxylic acid-modified copolymer (C) [A:(B + C)] is from 90:10 to 10:90, the content of  $\alpha,\beta$ -unsaturated monocarboxylic acid is 0.1 to 1.5 % by weight based on the total amount of the graft copolymer (B) and the carboxylic acid-modified copolymer (C), and the content of rubbery polymer is 5 to 30 % by weight based on the whole weight of the composition.

DETAILED DESCRIPTION OF THE INVENTIONPolyamide (A)

5 Examples of the polyamide (A) are polyamides prepared from aliphatic, alicyclic or aromatic diamines (e.g. ethylene diamine, diaminobutane, hexamethylenediamine, decamethylenediamine, dodecamethylenediamine, 2,2,4-and 2,4,4-trimethylhexamethylenediamine, 1,3-and 1,4-bis(aminomethyl)-cyclohexane, bis(p-aminocyclohexyl)methane, m-xylylenediamine, p-xylylenediamine, etc.) and aliphatic, alicyclic or aromatic dicarboxylic acids (e.g. adipic acid, suberic acid, sebacic acid, cyclohexanedicarboxylic  
10 acid, terephthalic acid, isophthalic acid, etc.); polyamides prepared by ring opening polymerization of lactams (e.g.  $\epsilon$ -caprolactam,  $\omega$ -dodecalactam, etc); polyamides prepared from 6-aminocaproic acid, 11-aminoundecanoic acid, 12-aminododecanoic acid and the like; and copolymerized or mixed polyamide thereof.

Because of mass and economical production, preferred are polycaproamide (nylon 6), polydodecamide  
15 (nylon 12), polytetramethylenedipamide (nylon 46), polyhexamethylenedipamide (nylon 66), polyhexamethylenesebacamide (nylon 610), copolymeric polyamides thereof (e.g. nylon 6/66, nylon 6/610), nylon 6/12, nylon 66/12, nylon 6/66/610/12) and mixtures thereof. Also preferred is a bis(p-aminocyclohexyl)-methane/terephthalic acid/isophthalic acid base polyamide.

The polyamide (A) to be used according to the present invention has a relative viscosity in sulfuric acid  
20 (a solution of 1 g of polyamide in 100 ml of 98 % sulfuric acid at 25°C) of not smaller than 2.0 and smaller than 3.0. When the relative viscosity in sulfuric acid is smaller than 2.0, or 3.0 or larger, the molded article has decreased weld strength. Preferably, the polyamide (A) has a relative viscosity in sulfuric acid of from 2.2 to 2.8.

The molecular structure of the polyamide (A) is not critical and may be a linear or branched polyamid .  
25 The linear polyamide may be prepared by a per se conventional method, while the branched polyamide is prepared by polymerizing the monomer(s) in the presence of a small amount of a polyfunctional branching agent having at least three polyamide-formable functional groups (e.g. bis( $\omega$ -aminoheptyl)amine, diethylenetriamine, trimesic acid, bislactam, etc.). Polymerization may be carried out in various manners such as melt polymerization, interfacial polymerization, solution polymerization, bulk polymerization, solid  
30 phase polymerization and combinations thereof. Generally, melt polymerization is suitable. When a monomer is a lactam, the polyamide can be prepared by anionic polymerization.

As the rubbery polymer to be used in the preparation of the graft copolymer (B), exemplified are diene base rubbery polymers (e.g. polybutadiene, butadiene-styrene copolymer, butadiene-acrylonitrile copolymer, etc.) and non-conjugated diene base rubbery polymers (e.g. ethylene-propylene copolymer, ethylene-propylene-non-conjugated diene copolymer, acrylic rubbery polymer, chlorinated polyethylene, etc.) and mixtures thereof. The rubbery polymer may be prepared by a conventional polymerization method such as emulsion polymerization, solution polymerization, bulk polymerization and suspension polymeriza-  
35 tion. When the emulsion polymerization is employed, there is no limitation on a particle size and gel content of the rubbery polymer. Preferably, the rubbery polymer has a particle size of 0.1 to 1  $\mu$ m and a gel content of 0 to 95 %.  
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Examples of the aromatic vinyl monomer are styrene,  $\alpha$ -methylstyrene, o-methylstyrene, m-methylstyrene, p-methylstyrene, t-butylstyrene,  $\alpha$ -methylvinyltoluene, dimethylstyrene, chlorostyrene, dichlorostyrene, bromostyrene, dibromostyrene, vinylnaphthalene and mixtures thereof. Among them, styrene is most preferred.

45 Examples of the cyanated vinyl monomer are acrylonitrile, methacrylonitrile, fumaronitrile and mixtures thereof. Among them, acrylonitrile is most preferred.

Examples of other vinyl monomer copolymerizable with the aromatic vinyl monomer and the cyanated vinyl monomer are alkyl esters of unsaturated carboxylic acids (e.g. methyl acrylate, ethyl acrylate, butyl acrylate, 2-ethylhexyl acrylate, methyl methacrylate, ethyl methacrylate, propyl methacrylate, 2-ethylhexyl  
50 methacrylate, etc.), maleimide compounds (e.g. maleimide, N-phenylmaleimide, N-methylmaleimide, N-cyclohexylmaleimide, etc.) and mixtures thereof.

The graft copolymer (B) is prepared by copolymerizing a monomer mixture comprising 50 to 90 % by weight of the aromatic vinyl monomer, 10 to 50 % by weight of the cyanated vinyl monomer and 0 to 40 % by weight of at least one of other vinyl monomers copolymerizable with the former two monomers in the  
55 presence of the rubbery polymer.

A weight ratio of the monomer mixture to the rubbery polymer in the graft copolymer is not critical. Preferably, the graft copolymer comprises 20 to 80 % by weight of the rubbery polymer and 80 to 20 % by weight of the monomer mixture.

When the monomeric composition of the graft copolymer (B) is outside the above ranges, the compatibility between the graft copolymer (B) and the carboxylic acid-modified copolymer (C) is poor so that the molded article made from the resin composition has decreased impact strength.

The graft copolymer may have any degree of grafting. Usually, the degree of grafting is from 20 to 100 %.

As the graft polymerization method, any of conventional methods such as emulsion, suspension, solution and bulk polymerization may be employed.

The carboxylic acid-modified copolymer (C) is (i) a copolymer prepared by copolymerizing the aromatic vinyl monomer, the cyanated vinyl monomer and  $\alpha,\beta$ -unsaturated monocarboxylic acid or (ii) a copolymer mixture consisting of the above copolymer (i) and a copolymer prepared by copolymerizing 50 to 90 % by weight of the aromatic vinyl monomer and 50 to 10 % by weight of the cyanated vinyl monomer. Each of the copolymers (i) and (ii) has an average composition of 50 to 89.5 % by weight of the aromatic vinyl monomer, 10 to 49.5 % by weight of the cyanated vinyl monomer and 0.5 to 20 % by weight of the  $\alpha,\beta$ -unsaturated monocarboxylic acid.

When the monomeric composition of the carboxylic acid-modified copolymer (C) is outside these ranges, the resin composition has decreased moldability or impact strength.

Examples of the aromatic vinyl monomer and the cyanated vinyl monomer which constitute the carboxylic acid-modified copolymer (C) are the same as those used in the preparation of the graft copolymer (B).

Examples of the  $\alpha,\beta$ -unsaturated monocarboxylic acid are acrylic acid, methacrylic acid and mixtures thereof.

As described above, the resin composition of the present invention contains, as one of the essential components, the carboxylic acid-modified copolymer comprising the  $\alpha,\beta$ -unsaturated monocarboxylic acid. Not only an unmodified copolymer of the aromatic vinyl monomer and the cyanated vinyl monomer but also an aromatic vinyl monomer/cyanated vinyl monomer copolymer modified with other modifiers such as anhydrides of dicarboxylic acids or esters of the  $\alpha,\beta$ -unsaturated carboxylic acid cannot provide a resin composition having good impact strength, moldability, tensile strength and weld strength.

The carboxylic acid-modified copolymer (C) may be prepared by any of the conventional polymerization methods such as emulsion, suspension, solution and bulk polymerization as well as combinations thereof. The  $\alpha,\beta$ -unsaturated monocarboxylic acid may be added to a polymerization system in any manner. It can be mixed with other monomers and added to the polymerization system, or added to the polymerization system in the form of an aqueous solution.

The resin composition contains the polyamide (A), the graft copolymer (B) and the carboxylic acid-modified copolymer (C) in such mixing ratio that the weight ratio of the polyamide (A) to the total amount of the graft copolymer (B) and the carboxylic acid-modified copolymer (C)  $[A:(B+C)]$  is from 90:10 to 10:90. Further, the content of  $\alpha,\beta$ -unsaturated monocarboxylic acid is from 0.1 to 1.5 % by weight based on the total amount of the graft copolymer (B) and the carboxylic acid-modified copolymer (C), and the content of the rubbery polymer is 5 to 30 % by weight based on the whole weight of the resin composition.

When the content of the polyamide (A) is less than 10 parts by weight or more than 90 parts by weight, the resin composition cannot achieve well balanced impact strength and tensile strength. In view of weld strength and appearance of the molded article, the weight ratio of polyamide (A) to the total amount of the graft copolymer (B) and the carboxylic acid-modified copolymer (C) is preferably from 90:10 to 30:70.

When the content of  $\alpha,\beta$ -unsaturated monocarboxylic acid is less than 0.1 % by weight based on the total amount of the graft copolymer (B) and the carboxylic acid-modified copolymer (C), the compatibility of the two copolymers (B) and (C) with the polyamide (A) is poor so that the impact strength of the molded article decreases, while when the content is more than 1.5 % by weight, the moldability of the resin composition and weld strength and appearance of the molded article unpreferably decrease.

When the content of rubbery polymer is less than 5 % by weight based on the whole weight of the resin composition, the molded article has decreased impact strength, while it is more than 30 % by weight, the molded article has significantly decreased tensile strength. In view of balanced impact strength, tensile strength and moldability, the content of rubbery polymer is preferably from 10 to 25 % by weight based on the whole weight of the resin composition.

The polyamide (A), the graft copolymer (B) and the carboxylic acid-modified copolymer (C) can be mixed in any form in any order. These components can be mixed in the form of powder, pellets or the like by simultaneously mixing them or by premixing two of them and then mixing the premixed components with the remaining one component. For melt mixing, any conventional means such as a Banbury mixer, rolls and an extruder can be used.

The resin composition of the present invention may contain a conventionally used additive such as an

antioxidant, an ultraviolet-light absorbing agent, a light stabilizer, an antistatic agent, a lubricant, a dye, a pigment, a plasticizer, a flame retardant, a mold release agent, a reinforcing material such as glass fiber, metal fiber, carbon fiber or metal flake. Further, the resin composition of the present invention may contain other thermoplastic resin (e.g. polyacetal, polycarbonate, polybutylene terephthalate, polyethylene terephthalate, polyphenyleneoxide, polymethyl methacrylate, polyvinyl chloride, etc.)

## PREFERRED EMBODIMENTS OF THE INVENTION

The present invention will be illustrated by following examples, in which "parts" and "%" are by weight unless otherwise indicated.

### Preparation Example 1 (Graft copolymer (B))

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#### Graft copolymer B-1

In the presence of polybutadiene latex having an average particle size of 0.45  $\mu\text{m}$  and a gel content of 83 % (60 parts, as the solid material), acrylonitrile (12 parts) and styrene (28 parts) were polymerized in an aqueous emulsion at 65°C for 5 hours to obtain an ABS graft copolymer latex (degree of grafting: 35 %, intrinsic viscosity of free acrylonitrile/styrene copolymer (measured in dimethylformamide at 30°C): 0.33 dl/g).

#### Graft copolymer B-2

In the same manner as in the preparation of the graft copolymer B-1 but using 50 parts of polybutadiene, 15 parts of acrylonitrile and 35 parts of styrene, emulsion polymerization was carried out to obtain an ABS graft copolymer latex (degree of grafting: 55 %, intrinsic viscosity of free acrylonitrile/styrene copolymer: 0.58 dl/g).

#### Graft copolymer B-3

In the presence of cross-linked polybutyl acrylate latex having an average particle size of 0.3  $\mu\text{m}$  (50 parts, as the solid material), acrylonitrile (15 parts) and styrene (35 parts) were polymerized in an aqueous emulsion at 65°C for 5 hours to obtain an AAS graft copolymer latex (degree of grafting: 50 %, intrinsic viscosity of free acrylonitrile/styrene copolymer: 0.72 dl/g).

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#### Graft copolymer B-4

In the presence of ethylene/propylene/ethylidenenorbornene (EPDM) having an iodine value of 21, Mooney viscosity 75 and propylene content of 50 %, acrylonitrile and styrene were polymerized in a mixed solvent of n-hexane and ethylene dichloride (weight ratio of 3:2) at 67°C for 10 hours to obtain an AES graft copolymer consisting of 50 % of EPDM, 15 % of acrylonitrile and 35 % of styrene (degree of grafting: 52 %, intrinsic viscosity of free acrylonitrile/styrene copolymer: 0.60 dl/g).

To each of the graft copolymers B-1, B-2 and B-3, 1 part an antioxidant (Sumilizer (a trade mark) NW manufactured by Sumitomo Chemical Co.) and 2 parts of trisnonylphenyl phosphite based on the solid content of the latex were added. The mixture was salted out with magnesium sulfate to separate and recover the graft copolymer. The graft polymer B-4 latex was poured in methanol to precipitate the graft copolymer followed by recovering.

### Preparation Example 2

(Carboxylic acid-modified copolymer (C))

Copolymer C-1

In a reactor which had been purged with nitrogen, pure water (120 parts) and potassium persulfate (0.3 part) were charged and heated to 65°C with stirring. Then, a monomer mixture of acrylonitrile (30 parts), styrene (70 parts) and t-dodecylm raptan (0.3 part) and an aqueous emulsifier solution (30 parts) containing sodium dodecylbenzenesulfonate (2 parts) were continuously added over 5 hours. Thereafter, the polymerization system was heated to 70°C and aged at that temperature for 3 hours to obtain a copolymer having the intrinsic viscosity (in dimethylformamide at 30°C) of 0.68 dl/g.

Copolymer C-2

In the same manner as in the preparation of the copolymer C-1 but using acrylonitrile (30 parts), styrene (65 parts) and methacrylic acid (5 parts), polymerization was carried out to obtain a copolymer having the intrinsic viscosity of 0.69 dl/g.

Copolymer C-3

In the same manner as in the preparation of the copolymer C-1 but using acrylonitrile (30 parts), styrene (60 parts) and methacrylic acid (10 parts), polymerization was carried out to obtain a copolymer having the intrinsic viscosity of 0.69 dl/g.

Copolymer C-4

In the same manner as in the preparation of the copolymer C-1 but using acrylonitrile (30 parts), styrene (55 parts) and methacrylic acid (15 parts), polymerization was carried out to obtain a copolymer having the intrinsic viscosity of 0.70 dl/g.

Copolymer C-5

In the same manner as in the preparation of the copolymer C-1 but using acrylonitrile (25 parts), styrene (50 parts) and methacrylic acid (25 parts), polymerization was carried out to obtain a copolymer having the intrinsic viscosity of 0.70 dl/g.

Each of the copolymers C-1 to C-5 was salted out with calcium chloride and then recovered.

The relative viscosities in sulfuric acid of the polyamide (A) used in Examples are as follows:

<u>Polyamide</u>	<u>Relative viscosity</u>
A-1: Nylon 6	1.8
A-2: Nylon 6	2.4
A-3: Nylon 6	2.8
A-4: Nylon 6	3.2
A-5: Nylon 6	3.5
A-6: Nylon 66	2.6
A-7: Nylon 66	3.0

## [Examples]

The polyamide (A), the graft copolymer (B) prepared in Preparation Example 1 and the carboxylic acid-modified copolymer (C) prepared in Preparation Example 2 were mixed in a composition shown in Tables 1-6 and melt mixed and pelletized by a twin-screw extruder having a diameter of 40 mm.

The mixing temperature was 250°C in case of nylon 6 and 280°C in case of nylon 66.

Physical properties of the resin composition were measured as follows and are shown in Tables 1-6:

10 Impact strength (notched Izod impact strength)

Impact strength is measured according to ASTM D-256.

15 Weld strength (falling ball impact test)

By using a mold having two gates, a test piece (60 mm × 60 mm × 3.18 mm) having a weld line is molded. A dart is placed on the test piece, and a steel ball was freely fallen on the dart. The results are expressed in terms of the minimum energy required for breaking the test piece.

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Moldability (flowability)

Flowability of the resin composition is measured by using a KOKA-type flow tester under following conditions:

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Composition containing nylon 6 250°C, 60 kg/cm<sup>2</sup>

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Composition containing nylon 66 270°C, 60 kg/cm<sup>2</sup>

35 Tensile strength Tensile strength is measured according to ASTM D-638.

Appearance

An article (150 mm x 150 mm x 3.18 mm) is molded from the resin composition and its appearance is visually evaluated according to following criteria:

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O: A surface has no uneven gloss and is uniform.

Δ: A surface has slight uneven gloss and irregularity.

X: A surface has severely uneven gloss and irregularity.

A test piece used in the measurement of impact strength, tensile strength and appearance was prepared by using 3.5 ounce injection molding machine at a cylinder temperature of 250°C in case of nylon 6 or 280°C in case of nylon 66.

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Examples 1-5 and Comparative Examples 1-9

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Tables 1 and 2 show influences of the relative viscosity in sulfuric acid of the polyamide (A) and the content of  $\alpha,\beta$ -monounsaturated carboxylic acid in the total weight of the graft copolymer (B) and the carboxylic acid-modified copolymer (C) on the properties of the resin compositions.

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Examples 6-9 and Comparative Example 10

Table 3 shows influence of the amount of the polyamide (A) on the properties of the resin compositions.

Examples 10-12 and Comparative Example 11

Table 4 shows influences of the amount of  $\alpha,\beta$ -monounsaturated carboxylic acid in the carboxylic acid-modified copolymer (C) on the properties of the resin composition.

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Examples 13-16

Table 5 shows possibility of the use of different kinds of graft copolymers.

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### Table 1

Table 6 shows that the resin composition of the present invention has good properties when glass fibers are added to the composition.

Example No.	C1	1	2	C2	C3	3	C4	C5	4	5	C6	C7	C8	C9
Composition (parts) (A) Polyamide ( $\eta_{sp}$ in $H_2SO_4$ ) A-1 (1.8) A-2 (2.4) A-3 (2.8) A-4 (3.2) A-5 (3.5) A-6 (2.6) A-7 (3.0)	50	50	50	50	50	60	60	50	50	50	50	50	50	50
(B) Graft copolymer B-1 B-2	40	40	40	40	40	30	30	40	40	40	40	40	40	40
(C) Carboxylic acid- modified copolymer C-1 C-2 C-3 C-4	10	10	10	10	10	10	10	8	8	5	5	10	10	10
Content of unsaturated carboxylic acid in (B)+(C)	1.0	1.0	1.0	1.0	1.0	1.25	1.25	0.2	0.2	0.5	0.5	2.0	3.0	0
Content of rubbery polymer in the composition	20	20	20	20	20	18	18	20	20	20	20	20	20	20

Table 2

Example No.	C1	1	2	C2	C3	3	C4	C5	4	5	C6	C7	C8	C9
Notched Izod impact strength (kg cm/cm)	72	82	87	89	95	70	71	64	73	72	89	71	81	8
Flowability (cc/min)	2.1	1.8	1.1	0.8	0.7	1.1	0.6	2.3	2.0	1.3	0.9	0.25	1.5	1.7
Tensile strength (kg/cm <sup>2</sup> )	470	480	490	490	490	530	540	470	470	480	490	490	480	480
Weld strength (kg/cm)														
+23°C	250	750	725	250	225	550	250	250	750	700	250	225	400	100
-30°C	75	200	175	75	75	225	100	75	200	175	75	50	100	50
Appearance	0	0	0	0	0	0	0	0	0	0	0	Δ	X	0

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10 Table 3

Example No.	C10	6	7	8	9
Composition (parts)					
(A) Polyamide A-3	100	80	50	40	30
(B) Graft copolymer B-1		15			
B-2			40	40	40
(C) Carboxylic acid- modified copolymer C-1				10	20
C-2		5	10	10	10
Content of unsaturated carboxylic acid in (B)+(C)	0	1.25	1.0	0.83	0.71
Content of rubbery polymer in the composition	0	9	20	20	20
Properties					
Notched Izod impact strength (kg cm/cm)	3.5	31	88	79	62
Flowability (cc/min)	5.7	3.5	1.5	1.1	0.7
Tensile strength (kg/cm <sup>2</sup> )	700	630	480	460	440
Weld strength (kg/cm)					
+23°C	850	800	750	650	350
-30°C	300	250	225	200	175
Appearance	0	0	0	0	Δ

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Table 4

Example No.	10	11	12	C11
<u>Composition (parts)</u>				
(A) Polyamide A-3	50	55	55	56
(B) Graft copolymer B-2	40	40	42	42
(C) Carboxylic acid- modified copolymer				
C-2	10			
C-3		5		
C-4			3	
C-5				2
Content of unsaturated carboxylic acid in (B)+(C)	1.0	1.1	1.0	1.1
Content of rubbery polymer in the composition	20	20	21	21
<u>Properties</u>				
Notched Izod impact strength (kg cm/cm)	87	83	85	68
Flowability (cc/min)	1.1	0.95	0.90	0.45
Tensile strength (kg/cm <sup>2</sup> )	470	480	460	460
Weld strength (kg/cm)				
+23°C	725	700	675	250
-30°C	175	150	125	50
Appearance	0	0	0	X

Table 5

Example No.	13	14	15	16
<u>Composition (parts)</u>				
(A) Polyamide				
A-3	50	50	45	45
(B) Graft copolymer				
B-3	42		35	
B-4		42		35
(C) Carboxylic acid- modified copolymer				
C-1			15	15
C-2	8	8		
C-3			5	5
Content of unsaturated carboxylic acid in (B)+(C)	0.8	0.8	0.9	0.9
Content of rubbery polymer in the composition	21	21	17.5	17.5
<u>Properties</u>				
Notched Izod impact strength (kg cm/cm)	97	102	88	90
Flowability (cc/min)	1.7	1.8	1.5	1.6
Tensile strength (kg/cm <sup>2</sup> )	500	510	540	545
Weld strength (kg/cm)				
+23°C	750	775	725	750
-30°C	225	225	200	200
Appearance	0	0	0	0

Table 6

Example No.	17	C12	18	C13	19	C14	20	C15
Composition (parts)								
(A) Polyamide A-2	50	50	50	50	65	65	65	65
(B) Graft copolymer B-1 B-2	40	40	40	40	30	30	30	30
(C) Carboxylic acid- modified copolymer C-1 C-2	10	10	10	10	5	5	5	5
Content of unsaturated carboxylic acid in (B)+(C)	1.0	0	1.0	0	0.7	0	0.7	0
Content of rubbery polymer in the composition	20	20	20	20	18	18	18	18
Weight ratio of Composition/glass fiber *1)	85/15	85/15	70/30	70/30	85/15	85/15	70/30	70/30

Table 6 (continued)

Example No.	17	18	19	20	C14	C15
Properties						
Notched Izod impact strength (kg cm/cm)	26	23	20	23	7	7
Flowability (cc/min)	1.5	1.2	1.6	1.3	2.5	1.5
Tensile strength (kg/cm <sup>2</sup> )	985	1245	1100	1455	820	1255
Weld strength (kg/cm)						
+23°C	125	100	100	75	50	<25
-30°C	75	50	75	50	25	<25
Appearance	O	Δ	O	Δ	O	Δ
Deformation temperature (°C)	125	180	138	210	140	210

Note: \*1) Manufactured by Nitto Boseki Kabushikikaisha, 3PE-471 (cut length 3mm, fiber diameter 10 μm).

## Claims

1. A thermoplastic resin composition comprising:
  - (A) polyamide having a relative viscosity in sulfuric acid of not smaller than 2.0 and smaller than 3.0,

(B) a graft copolymer which is obtainable by copolymerizing 50 to 90 % by weight of an aromatic vinyl monomer, 10 to 50 % by weight of a cyanated vinyl monomer and 0 to 40 % by weight of other vinyl monomer copolymerizable with the former two monomers in the presence of a rubbery polymer and

(C) a carboxylic acid-modified copolymer comprising monomeric unites derived from 50 to 89.5 % by weight of an aromatic vinyl monomer, 10 to 49.5 % by weight of a cyanated vinyl monomer and 0.5 to 20 % by weight of an  $\alpha,\beta$ -unsaturated monocarboxylic acid

wherein a weight ratio of polyamide (A) to a total amount of the graft copolymer (B) and the carboxylic acid-modified copolymer (C) [A:(B + C)] is from 90:10 to 10:90, the content of  $\alpha,\beta$ -unsaturated monocarboxylic acid is 0.1 to 1.5 % by weight based on the total amount of the graft copolymer (B) and the carboxylic acid-modified copolymer (C), and the content of rubbery polymer is 5 to 30 % by weight based on the whole weight of the composition.

2. The thermoplastic resin according to claim 1, wherein the weight ratio of polyamide (A) to the total amount of the graft copolymer (B) and the carboxylic acid-modified copolymer (C) is from 90:10 to 30:70.

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